PART 2: Exploring Doctor Prevalence

Data Sources used:

Health Dataset https://chronicdata.cdc.gov/500-Cities/500-Cities-Census-Tract-level-Data-GIS-Friendly-Fo/k25u-mg9b (https://chronicdata.cdc.gov/500-Cities/500-Cities-Census-Tract-level-Data-GIS-Friendly-Fo/k25u-mg9b)

Socioeconomics Dataset https://svi.cdc.gov/data-and-tools-download.html (https://svi.cdc.gov/data-and-tools-download.html)

Better Doctor API https://developer.betterdoctor.com/documentation15 (https://developer.betterdoctor.com/documentation15)

Shapefiles of CA cities https://purl.stanford.edu/zd071bk4213 (https://purl.stanford.edu/zd071bk4213)

In [1]:
```
import geopandas as gpd
import pandas as pd
import numpy as np
import shapely as shape
import geopy.distance as gpy #install -c conda-forge geopy
import requests
import requests_cache
import matplotlib.pyplot as plt
from plotnine import *
import seaborn as sns
from random import randint
from time import sleep
requests_cache.install_cache("mycache")
pd.options.mode.chained_assignment = None  # default='warn'

import warnings
warnings.filterwarnings('ignore')
```

First, we find the cities at highest and lowest risk for diabetes and mental illness.

In [2]:
```
#Extract data for cities in California only
health = pd.read_csv('500_Cities__Census_Tract-level_Data__GIS_Friendly_Format___2018_release.csv')
health = health[health['StateAbbr'] == 'CA']
health.head()
```

Out[2]:

	StateAbbr	PlaceName	PlaceFIPS	TractFIPS	Place_TractID	Population2010	ACCESS2_Cru
1	CA	Los Angeles	644000	6037206032	0644000-06037206032	5275	
2	CA	Pasadena	656000	6037462001	0656000-06037462001	3974	
3	CA	Fullerton	628000	6059011504	0628000-06059011504	5473	
9	CA	San Diego	666000	6073003112	0666000-06073003112	4574	
10	CA	Concord	616000	6013336102	0616000-06013336102	7595	

5 rows × 65 columns

In [3]:
```
z = health['Population2010'].reset_index()
```

In [4]:
```
#Extract health information we're interested in
health_needed = health[['Place_TractID','PlaceName','BPHIGH_CrudePrev','CASTHMA_CrudePrev','COPD_CrudePrev',
           'CSMOKING_CrudePrev','DIABETES_CrudePrev','HIGHCHOL_CrudePrev','MHLTH_CrudePrev','SLEEP_CrudePrev']]

population_total = health[['PlaceName','Population2010']]
population_total= population_total.groupby(['PlaceName']).sum().reset_index()
population_total = population_total.rename(columns = {population_total.columns[1]: "Total Population"})
population_each = health[['Place_TractID','PlaceName','Population2010']]
population_proportion = pd.merge(population_each,population_total , on = 'PlaceName')

#Calculate the population weight for each disease percentage
population_proportion['Population weight'] = population_proportion['Population2010']/population_proportion['Total Population']
population_weight = population_proportion[['Place_TractID','Population weight']]
health_needed = pd.merge(health_needed,population_weight , on = 'Place_TractID')
```

In [5]:
```
#Calculate the weighted average of each disease
for i in range(8):
    health_needed.iloc[:,i+2] = health_needed.iloc[:,i+2]*health_needed.iloc
[:,10]

health_needed = health_needed.iloc[:,1:10]
health_needed['Population2010'] = z.Population2010
health_needed.head()
cityhealthcp= health_needed.groupby(['PlaceName']).sum().reset_index()
```

In [6]:
```
#Extract disease crude prevalence data
healthcp = health[['TractFIPS','PlaceName','DIABETES_CrudePrev','MHLTH_CrudePr
ev','SLEEP_CrudePrev', 'Population2010']]
```

In [7]:
```
#Sort cities by crude prevalence of diabetes from low to high
Diabetes = cityhealthcp.sort_values('DIABETES_CrudePrev')
```

In [8]:
```
#The 5 cities with lowest crude prevalence of diabetes are:
list(Diabetes.head(5)['PlaceName'])
```

Out[8]:
```
['Redondo Beach', 'San Ramon', 'Berkeley', 'Folsom', 'Irvine']
```

In [9]:
```
#The 5 cities with the highest crude prevalence of diabetes are:
list(Diabetes.tail(5)['PlaceName'])
```

Out[9]:
```
['Westminster', 'Inglewood', 'San Bernardino', 'Compton', 'Hemet']
```

In [10]:
```
#Sort cities by crude prevalence of mental illness from low to high
mental_health = cityhealthcp.sort_values('MHLTH_CrudePrev')
```

In [11]:
```
#The 5 cities with the lowest crude prevalence of mental illness are:
list(mental_health.head(5)['PlaceName'])
```

Out[11]:
```
['San Ramon', 'Sunnyvale', 'Newport Beach', 'Fremont', 'Milpitas']
```

In [12]:
```
#The 5 cities with the highest crude prevalence of mental illness are:
list(mental_health.tail(5)['PlaceName'])
```

Out[12]:
```
['Hesperia', 'Merced', 'Compton', 'Lynwood', 'San Bernardino']
```

To find the number of doctors per city, we extract doctor prevalence by location from BetterDoctor's API.

In [13]:
```
#function
key = "a9ed2c27d2f8d4bd41631bf9922c9e82"
def find_numdoc(city):
    response = requests.get("https://api.betterdoctor.com/2016-03-01/doctors",
params = {
        "location": city,
        "user_key": key
    })
    sleep(randint(0,2))
    response.raise_for_status()
    result = response.json()
    return result['meta']['total']
```

In [14]:
```
cityhealthcp['nameforapi'] = 'ca-'+ cityhealthcp['PlaceName']
doc1 = pd.DataFrame()
doc1['city'] = None

doc2 = pd.DataFrame()
doc2['city'] = None

doc3 = pd.DataFrame()
doc3['city'] = None

#betterdoctor api allows only 40 requests every minute, so separate the cities
into blocks of 40 or less
for i in range(0, 40):
    doc1.loc[i,'city'] = cityhealthcp['nameforapi'][i].lower()
    doc1.loc[i,'city'] = doc1.loc[i,'city'].replace(" ",'-')

for i in range(40,81):
    doc2.loc[i,'city'] = cityhealthcp['nameforapi'][i].lower()
    doc2.loc[i,'city'] = doc2.loc[i,'city'].replace(" ",'-')

for i in range(81,121):
    doc3.loc[i,'city'] = cityhealthcp['nameforapi'][i].lower()
    doc3.loc[i,'city'] = doc3.loc[i,'city'].replace(" ",'-')
```

In [15]:
```
#fix name for city of ventura
doc3.loc[86, 'city'] = 'ca-ventura'
```

In [16]:
```
doc1['#doctors'] = None
doc1['#doctors'] = list(map(find_numdoc, doc1['city']))
```

In [17]:
```
doc2['#doctors'] = None
doc2['#doctors'] = list(map(find_numdoc, doc2['city']))
```

In [18]:
```
doc3['#doctors'] = None
doc3['#doctors'] = list(map(find_numdoc, doc3['city']))
```

In [19]:
```
doc = pd.concat([doc1, doc2, doc3])
doc['docs/1000'] = None
doc['docs/1000'] = doc['#doctors'] / cityhealthcp['Population2010']*1000
```

In [20]:
```
cityhealthcp.head()
```

Out[20]:

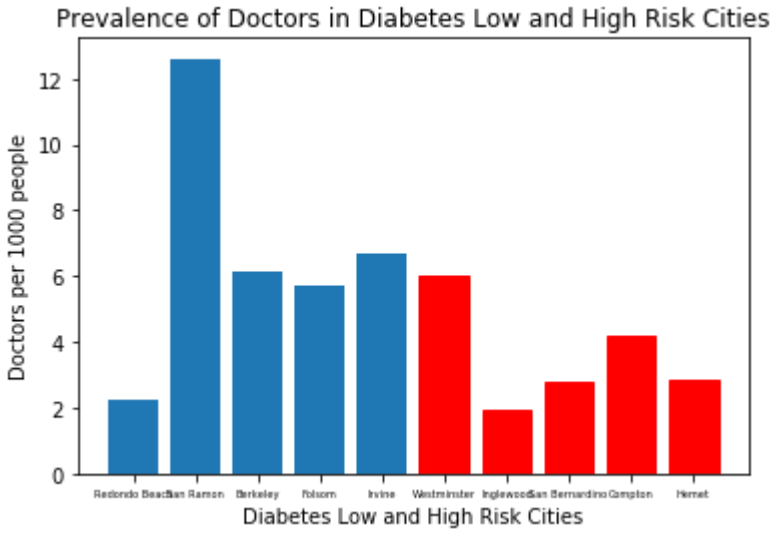
	PlaceName	BPHIGH_CrudePrev	CASTHMA_CrudePrev	COPD_CrudePrev	CSMOKING_CrudePr
0	Alameda	25.719995	8.287716	4.293206	11.7527
1	Alhambra	27.658207	6.809047	4.142895	11.1419
2	Anaheim	25.141230	8.455059	5.181492	14.3644
3	Antioch	27.395956	9.286676	5.529028	15.7018
4	Apple Valley	33.963456	10.131809	7.781888	17.0605

In [21]:
```
cities = ('ca-redondo-beach', 'ca-san-ramon','ca-berkeley',
          'ca-folsom', 'ca-irvine','ca-westminster', 'ca-inglewood',
          'ca-san-bernardino', 'ca-compton', 'ca-hemet')

#hi - high risk, lo - low risk
hilow = doc.loc[doc['city'].isin(cities)]

#num = pd.DataFrame()
#num['city'] = cities
#num = num.set_index('city')
hilow = hilow.set_index('city')
hilow = hilow.reindex(['ca-redondo-beach', 'ca-san-ramon','ca-berkeley',
          'ca-folsom', 'ca-irvine','ca-westminster', 'ca-inglewood',
          'ca-san-bernardino', 'ca-compton', 'ca-hemet'])
hilow
#num = pd.DataFrame()
#num['doc/1000'] = pd.DataFrame(list(map(find_numdoc, cities))/)
#num['city'] = ('Irvine', 'Redondo Beach', 'Murrieta', 'Chino Hills',
              #'San Ramon', 'El Monte', 'Rialto', 'Inglewood', 'Hemet',
               #'Compton')

index = np.arange(10)
b = plt.bar(index, hilow['docs/1000'])
plt.xlabel('Diabetes Low and High Risk Cities')
plt.ylabel('Doctors per 1000 people')
plt.xticks(index, ('Redondo Beach', 'San Ramon', 'Berkeley', 'Folsom', 'Irvin
e',
                   'Westminster', 'Inglewood', 'San Bernardino',
                   'Compton', 'Hemet'), fontsize = 5)
plt.title('Prevalence of Doctors in Diabetes Low and High Risk Cities')
b[5].set_color('r')
b[6].set_color('r')
b[7].set_color('r')
b[8].set_color('r')
b[9].set_color('r')
plt.savefig('g1.png')
```

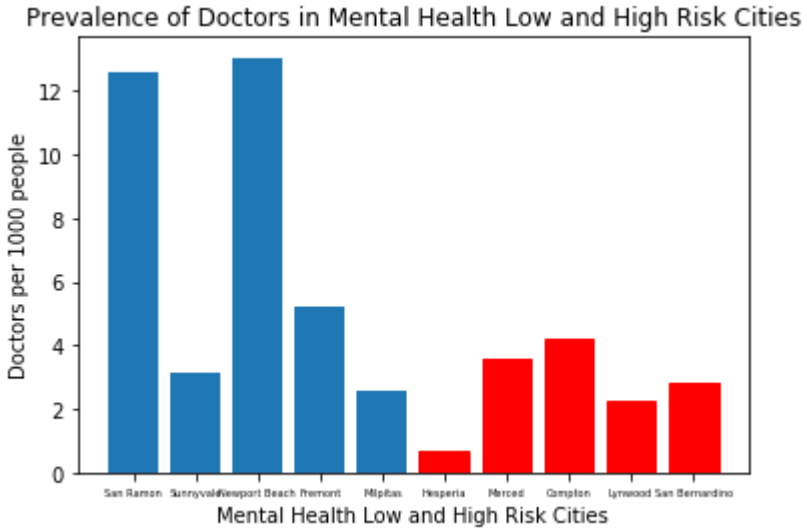


In [22]:
```
cities = ('ca-san-ramon', 'ca-sunnyvale', 'ca-newport-beach', 'ca-fremont',
          'ca-milpitas', 'ca-hesperia', 'ca-merced', 'ca-compton', 'ca-lynwoo
d',
          'ca-san-bernardino')

hilow = doc.loc[doc['city'].isin(cities)]

#num = pd.DataFrame()
#num['city'] = cities
#num = num.set_index('city')
hilow = hilow.set_index('city')
hilow = hilow.reindex(['ca-san-ramon', 'ca-sunnyvale', 'ca-newport-beach', 'ca
-fremont',
          'ca-milpitas', 'ca-hesperia', 'ca-merced', 'ca-compton', 'ca-lynwoo
d',
          'ca-san-bernardino'])
hilow
#num = pd.DataFrame()
#num['doc/1000'] = pd.DataFrame(list(map(find_numdoc, cities))/)
#num['city'] = ('Irvine', 'Redondo Beach', 'Murrieta', 'Chino Hills',
              #'San Ramon', 'El Monte', 'Rialto', 'Inglewood', 'Hemet',
               #'Compton')

index = np.arange(10)
b = plt.bar(index, hilow['docs/1000'])
plt.xlabel('Mental Health Low and High Risk Cities')
plt.ylabel('Doctors per 1000 people')
plt.xticks(index, ('San Ramon', 'Sunnyvale', 'Newport Beach', 'Fremont',
                   'Milpitas', 'Hesperia', 'Merced', 'Compton', 'Lynwood',
                   'San Bernardino'), fontsize = 5)
plt.title('Prevalence of Doctors in Mental Health Low and High Risk Cities')
b[5].set_color('r')
b[6].set_color('r')
b[7].set_color('r')
b[8].set_color('r')
b[9].set_color('r')
plt.savefig('g2.png')
```



Plot the relationship between doctors and diabetes for all cities.

In [23]:
```
doc['PlaceName'] = cityhealthcp['PlaceName']
health_doc = pd.merge(cityhealthcp, doc, left_on = "PlaceName", right_on = "Pl
aceName")
```

In [24]:
```
diabvdoc = ggplot(health_doc, aes(x = "docs/1000", y = "DIABETES_CrudePrev"))
+geom_point() + geom_density_2d() + labs(title = 'Doctor Prevalence vs. Diabet
es Risk for Cities', x = 'Doctors per 1000 people', y = 'Crude Prevalence of D
iabetes')
diabvdoc
ggsave(diabvdoc, 'g3.png')
```

In [25]:
```
mhvdoc = ggplot(health_doc, aes(x = "docs/1000", y = "MHLTH_CrudePrev"))+geom_
point() + geom_density_2d() + labs(title = 'Doctor Prevalence vs. Poor Mental
 Health Risk for Cities', x = 'Doctors per 1000 people', y = 'Crude Prevalence
of Poor Mental Health')
ggsave(mhvdoc, 'g4.png')
```

Find relationship between doctors within a certain radius and disease prevalence

In [26]:
```
tracts = gpd.read_file("data/Cities2015.shp")
tracts.head()
```

Out[26]:

	NAME	CityType	Pop2010	Land_sqmi	DateIncorp	WebLink	County	Notes
0	Benicia	City	26997	12.93	1850-03-27	http://www.ci.benicia.ca.us	Solano	None
1	Vallejo	City	115942	30.67	1868-03-30	http://www.ci.vallejo.ca.us	Solano	None
2	Rio Vista	City	7360	6.69	1894-01-06	http://www.ci.rio-vista.ca.us	Solano	None
3	Colusa	City	5971	1.83	1868-06-16	http://www.colusa-ca.gov	Colusa	06-15-007
4	Williams	City	5123	5.44	1920-05-17	http://www.cityofwilliams.org	Colusa	None

In [27]:
```
#social vulnerability index data from 2016
svi = gpd.read_file("SVI2016_US/SVI2016_US.shp")
```

In [28]:
```
#we join the svi data and health data at census tract level
#rename svi tract column to match column name in health
svi.rename(columns={'FIPS': 'TractFIPS'}, inplace=True)

#convert tract column to int64 type to match type in health
svi['TractFIPS'] = svi['TractFIPS'].astype(np.int64)
```

In [29]:
```
#create new dataset from merged svi and health data
healthsvi = healthcp.merge(svi, on='TractFIPS', how='inner')
healthsvi.head()
```

Out[29]:

	TractFIPS	PlaceName	DIABETES_CrudePrev	MHLTH_CrudePrev	SLEEP_CrudePrev	Populat
0	6037206032	Los Angeles	15.5	15.0	38.9	
1	6037462001	Pasadena	11.6	15.7	40.2	
2	6059011504	Fullerton	4.6	14.1	33.4	
3	6073003112	San Diego	12.9	13.7	39.1	
4	6013336102	Concord	9.5	16.4	38.1	

5 rows × 130 columns

In [30]:
```
d = ('San Bernardino', 'Compton', 'Hemet')
b = ('Compton', 'Lynwood', 'San Bernardino')
worst3diab = healthsvi.loc[healthsvi['PlaceName'].isin(d)].reset_index()
worst3mh = healthsvi.loc[healthsvi['PlaceName'].isin(b)].reset_index()
```

Using the shapefiles, we write a function to find the approximate radius of a tract.

In [31]:
```
#function to find the radius of a tract
def find_radius(fips):
    shape = tuple(svi.loc[svi['TractFIPS']==fips].geometry)[0]
    center = tuple(shape.centroid.coords)[0]
    # reverse (lon,lat) to (lat,lon)
    center = center[::-1]
    #create dataframe to store radiuses
    r = pd.DataFrame()
    r['rad'] = None
    #find max between center and all boundary points
    for i in range(0, len(tuple(shape.boundary.coords))):
        bounds = tuple(shape.boundary.coords)[i]
        bounds = bounds[::-1]
        r.loc[i, 'rad'] = gpy.distance(center, bounds)
    #convert from km to miles
    radius = max(r.rad)
    convers_factor = 0.621371
    radius =  radius * convers_factor
    return radius
```

In [32]:
```
#test
find_radius(6037543100)
```

Out[32]: Distance(0.9072218364655207)

In [33]:
```
#get radius of census tracts for 3 cities with highest risk of diabetes
worst3diab['radius1'] = None
worst3diab['radius5'] = None
worst3diab['radius10'] = None
for i in range(0,len(worst3diab.TractFIPS)):
    try:
        worst3diab.radius1[i] = str(float(str(find_radius(worst3diab.TractFIPS
[i])).replace('km',''))+1)
        worst3diab.radius5[i] = str(float(str(find_radius(worst3diab.TractFIPS
[i])).replace('km',''))+5)
        worst3diab.radius10[i] = str(float(str(find_radius(worst3diab.TractFIP
S[i])).replace('km',''))+10)
    except NotImplementedError:
        continue
```

In [34]:
```
#get radii of tracts in 3 highest risk cities for poor mental health
worst3mh['radius1'] = None
worst3mh['radius5'] = None
worst3mh['radius10'] = None

for i in range(0,len(worst3mh.TractFIPS)):
    try:
        worst3mh.radius1[i] = str(float(str(find_radius(worst3mh.TractFIPS[i
])).replace('km',''))+1)
        worst3mh.radius5[i] = str(float(str(find_radius(worst3mh.TractFIPS[i
])).replace('km',''))+5)
        worst3mh.radius10[i] = str(float(str(find_radius(worst3mh.TractFIPS[i
])).replace('km',''))+10)
    except NotImplementedError:
        continue
```

In [35]:
```
#get lat, lon, and desired radius of diabetes risk cities
worst3diab['lat']=None
worst3diab['lon']=None

for i in range(0,len(worst3diab)):
    shape = worst3diab.geometry[i]
    center = tuple(shape.centroid.coords)[0]
    lat = str(center[1])
    lon = str(center[0])
    worst3diab.lat[i] = lat
    worst3diab.lon[i] = lon

worst3diab['apientryr1'] = worst3diab['lat']+ ',' +worst3diab['lon']+','+worst
3diab['radius1']
worst3diab['apientryr5'] = worst3diab['lat']+ ',' +worst3diab['lon']+','+worst
3diab['radius5']
worst3diab['apientryr10'] = worst3diab['lat']+ ',' +worst3diab['lon']+','+wors
t3diab['radius10']
```

In [36]:
```
#get lat, lon, and desired radius of poor mental health risk cities
worst3mh['lat']=None
worst3mh['lon']=None

for i in range(0,len(worst3mh.TractFIPS)):
    shape = worst3mh.geometry[i]
    center = tuple(shape.centroid.coords)[0]
    lat = str(center[1])
    lon = str(center[0])
    worst3mh.lat[i] = lat
    worst3mh.lon[i] = lon

#set columns for api entries of location data for mental health cities
worst3mh['apientryr1'] = worst3mh['lat']+ ',' +worst3mh['lon']+','+worst3mh['r
adius1']
worst3mh['apientryr5'] = worst3mh['lat']+ ',' +worst3mh['lon']+','+worst3mh['r
adius5']
worst3mh['apientryr10'] = worst3mh['lat']+ ',' +worst3mh['lon']+','+worst3mh[
'radius10']
```

The following function extracts the number of doctors within a certain radius from the API. The individual key I used is listed.

In [37]:
```
key = "a9ed2c27d2f8d4bd41631bf9922c9e82"
def find_numdocrad(entry):
    response = requests.get("https://api.betterdoctor.com/2016-03-01/doctors",
params = {
        "location": entry,
        "user_key": key
    })
    sleep(randint(0,4))
    response.raise_for_status()
    result = response.json()
    return result['meta']['total']
```

In [38]:
```
worst3diab['docsinr1'] = list(map(find_numdocrad, worst3diab['apientryr1']))
worst3diab['docsinr5'] = list(map(find_numdocrad, worst3diab['apientryr5']))
worst3diab['docsinr10'] = list(map(find_numdocrad, worst3diab['apientryr10']))
```

In [39]:
```
worst3diab['docsinr1/1000ppl'] = worst3diab['docsinr1'] / worst3diab['Populati
on2010'] * 1000
worst3diab['docsinr5/1000ppl'] = worst3diab['docsinr5'] / worst3diab['Populati
on2010'] * 1000
worst3diab['docsinr10/1000ppl'] = worst3diab['docsinr10'] / worst3diab['Popula
tion2010'] * 1000
```

In [40]:
```
#log scale number of doctors per 1000 people
worst3diab['log_docsinr1/1000ppl'] = np.log10(worst3diab['docsinr1/1000ppl'] +
1)
worst3diab['log_docsinr5/1000ppl'] = np.log10(worst3diab['docsinr5/1000ppl'] +
1)
worst3diab['log_docsinr10/1000ppl'] = np.log10(worst3diab['docsinr10/1000ppl']
+ 1)
```

In [41]:
```
worst3mh['docsinr1'] = list(map(find_numdocrad, worst3mh['apientryr1']))
worst3mh['docsinr5'] = list(map(find_numdocrad, worst3mh['apientryr5']))
worst3mh['docsinr10'] = list(map(find_numdocrad, worst3mh['apientryr10']))
```

In [42]:
```
worst3mh['docsinr1/1000ppl'] = worst3mh['docsinr1'] / worst3mh['Population201
0'] * 1000
worst3mh['docsinr5/1000ppl'] = worst3mh['docsinr5'] / worst3mh['Population201
0'] * 1000
worst3mh['docsinr10/1000ppl'] = worst3mh['docsinr10'] / worst3mh['Population20
10'] * 1000
```

In [43]:
```
#log scale number of doctors per 1000 people
worst3mh['log_docsinr1/1000ppl'] = np.log10(worst3mh['docsinr1/1000ppl'] + 1)
worst3mh['log_docsinr5/1000ppl'] = np.log10(worst3mh['docsinr5/1000ppl'] + 1)
worst3mh['log_docsinr10/1000ppl'] = np.log10(worst3mh['docsinr10/1000ppl'] + 1
)
```

In [44]:
```
drad1 = ggplot(worst3diab, aes(x = "log_docsinr1/1000ppl", y = "DIABETES_Crude
Prev")) + geom_point() + geom_density_2d() + labs(title = 'Doctors Within 1 mi
le vs. Diabetes Crude Prevalence', x = 'Log(Doctors within 1 mile of Tract Bou
ndary Per 1000 People)',
     y = 'Diabetes Crude Prevalence')
ggsave(drad1, 'g5.png')
```

In [45]:
```
drad5 = ggplot(worst3diab, aes(x = "log_docsinr5/1000ppl", y = "DIABETES_Crude
Prev")) + geom_point() + geom_density_2d() + labs(title = 'Doctors Within 5 mi
les vs. Diabetes Crude Prevalence', x = 'Log(Doctors within 5 mile of Tract Bo
undary Per 1000 People)',
     y = 'Diabetes Crude Prevalence')
ggsave(drad5, 'g6.png')
```

In [46]:
```
drad10 = ggplot(worst3diab, aes(x = "log_docsinr10/1000ppl", y = "DIABETES_Cru
dePrev")) + geom_point() + geom_density_2d() + labs(title = 'Doctors Within 10
miles vs. Diabetes Crude Prevalence', x = 'Log(Doctors within 10 mile of Tract
Boundary Per 1000 People)',
     y = 'Diabetes Crude Prevalence')
ggsave(drad10, 'g7.png')
```

In [47]:
```
mrad1 = ggplot(worst3mh, aes(x = "log_docsinr1/1000ppl", y = "MHLTH_CrudePrev"
)) + geom_point() + geom_density_2d() + labs(title = 'Doctors Within 1 miles v
s. Crude Prevalence of Poor Mental Health', x = 'Log(Doctors within 1 mile of
 Tract Boundary Per 1000 People)',
     y = 'Mental Health Crude Prevalence')
ggsave(mrad1, 'g8.png')
```

In [48]:
```
mrad5 = ggplot(worst3mh, aes(x = "log_docsinr5/1000ppl", y = "MHLTH_CrudePrev"
)) + geom_point() + geom_density_2d() + labs(title = 'Doctors Within 1 miles v
s. Crude Prevalence of Poor Mental Health', x = 'Log(Doctors within 5 mile of
 Tract Boundary Per 1000 People)',
     y = 'Mental Health Crude Prevalence')
ggsave(mrad5, 'g9.png')
```

In [49]:
```
mrad10 = ggplot(worst3mh, aes(x = "log_docsinr10/1000ppl", y = "MHLTH_CrudePre
v")) + geom_point() + geom_density_2d() + labs(title = 'Doctors Within 10 mile
s vs. Crude Prevalence of Poor Mental Health', x = 'Log(Doctors within 10 mile
of Tract Boundary Per 1000 People)',
     y = 'Mental Health Crude Prevalence')
ggsave(mrad1, 'g10.png')
```